REMARKS

The Office Action dated October 30, 2003 has been received and carefully noted. The above amendments and the following remarks are submitted as a full and complete response thereto. Accordingly, claims 1-20 are pending in this application and are submitted for consideration.

Claims 1, 9, 13 and 17-20 were rejected under 35 U.S.C. § 102(b) as being anticipated by Nakata et al. (U.S. Patent No. 6,118,276, "Nakata"). However, Applicants respectfully submit that claims 1, 9, 13 and 17-20 recite subject matter that is neither disclosed nor suggested in Nakata.

Claim 1 recites a system for detecting misfire for an internal combustion engine having an ignition plug. The ignition plug is installed to face into a combustion chamber of a cylinder of the engine and is connected to an ignition coil, which produces spark discharge when supplied with discharge current from the ignition coil to ignite air-fuel mixture in the combustion chamber. The system includes a current detection circuit which detects ionization current that flows following the discharge current during a period. A misfire detector detects the occurrence of misfire of the engine based on the detected current. A processing delay circuit inputs at least one of the discharge current and the ionization current and based on the inputted current, delays starting of the period by a time point which is not earlier than termination of the discharge current.

Claim 9 recites a system for detecting misfire for an internal combustion engine having an ignition plug. The ignition plug is installed to face into a combustion chamber of a cylinder of the engine and connected to an ignition coil which produces a discharge spark when supplied with discharge current from the ignition coil to ignite air-fuel

mixture in the combustion chamber. The system includes a current detection circuit which detects ionization current that flows following the discharge current during a period. A misfire detector detects the occurrence of misfire of the engine based on the detected current. A processing delay circuit which inputs at least one of the discharge current and the ionization current and based on the inputted current, delays starting of the period by a time after the ionization current begins to flow.

Claim 13 recites a system for detecting misfire for an internal combustion engine having an ignition plug, installed to face into a combustion chamber of a cylinder of the engine and connected to an ignition coil, which produces a discharge spark when supplied with discharge current from the ignition coil to ignite air-fuel mixture in the combustion chamber. The system includes a current detection circuit which detects ionization current, that flows following the discharge current, during a period. A misfire detector detects occurrence of misfire of the engine based on the detected current. A processing delay circuit which inputs the discharge current and based on the inputted current, delays starting of the period by a time after the discharge current cease to flow.

Claim 17 recites a method for detecting misfire for an internal combustion engine having an ignition plug. The plug is installed to face into a combustion chamber of a cylinder of the engine and connected to an ignition coil which produces spark discharge when supplied with discharge current from the ignition coil to ignite air-fuel mixture in the combustion chamber. The method includes the steps of: detecting ionization current, that flows following the discharge current, during a period; detecting occurrence of misfire of the engine based on the detected current; and inputting at least one of the discharge current and the ionization current and based on the inputted current, delays

starting of the period by a time point which is not earlier than termination of the discharge current.

In making this rejection, the Office Action took the position that Nakata discloses all of the elements of the claimed invention. However, it is respectfully submitted that the prior art fails to disclose or suggest the structure of the claimed invention, and therefore, fails to provide the advantages of the present invention. For example, the system of the present invention is configured to include a processing delay circuit which inputs at least one of the discharge current and the ionization current and based on the inputted current, delays starting of the period of the flow of ionization current by a time point which is not earlier than termination of the discharge current.

With this arrangement, since the engine misfire detection system according to the present invention is configured to delay the start of the integration period by a prescribed period (the masking period) from the start of the period of ionization current occurrence, waveforms during the time of inductive noise occurrence can be reliably masked and prevented from exerting any adverse effect. False misfire detection caused by such a waveform can therefore be prevented to enable still more accurate detection of misfire.

Nakata discloses an ion current detection device 10 that is designed to hold an ion current output voltage within a prescribed limit to insure proper operation of a processing device 20 connected to the outside, while at the same time shortening the decay time of a LC resonance associated with an ignition coil 1. As shown in Fig. 1, ion current detection circuit 10 is located at the other end of the secondary winding 1b of ignition coil 1. Capacitor 11 is an ion current generating source and is connected to the

secondary winding 1b. A voltage-regulator diode (Zener diode) 12 is connected in parallel with capacitor 11 and limits the voltage to be charged into the capacitor 11 by the ignition coil secondary current from a specified value. Capacitor 11 is grounded via diode 13, load resistor 14 and ion current detecting resistor 15. When the ignition signal goes active and transistor 3 is turned on, current flows to the primary winding 1a of the ignition coil 1. When the ignition signal is set inactive and transistor 3 is turned off, primary current is shut off inducing a high voltage and the secondary winding 1b of ignition coil 1 causing a spark to occur as sparkplug 4.

Thus, when a high negative voltage is applied to the center electrode 4a of sparkplug 4, a spark is produced between the center electrode 4a and the outer electrode 4b, and a current pulse from the secondary winding 1b of the ignition coil 1. When the air/fuel mixture inside the combustion chamber is burned after being ignited by the spark at the sparkplug 4, the air/fuel mixture is ionized. When the mixture is in the ionized state, conductivity is maintained across the gap between the two electrodes of sparkplug 4. Because a voltage is applied between the two electrodes of sparkplug 4 by the charge voltage of the capacitor 11, and ion current flows. The ion current flows from one end of capacitor 11 back to the other end thereof passing through the ignition coil secondary winding 1b, sparkplug 4, the ion current detecting resistor 15 and the load resistor 14, as shown in Fig. 3. Voltage equal to (-ion current value) xdetecting resistor value appears at the node between the ion current resistor 15 and the low resistor 14. This voltage is inverted by inverting circuit 16. The output of inverting circuit 16 supplied as the ion current output to the processing circuit 20.

In the present invention, at least one of the discharge current and ionization current is detected and based on the detected current, starting of the discharging period is delayed (masked). Accordingly, regardless of the variance of the discharging period of time of the ignition coil, the noise can be masked without fail, which is a benefit of the claimed invention.

In the Office Action, it was asserted that in Nakata, element 20 represents both the misfire detector and the processing delay circuit. However, Applicants submit that that this is an improper rejection under 35 U.S.C. § 102(b) because, for example, in Applicants' specification, the ECU14 provides misfire detection, and processing delay unit 90 delays the integration start time. However, Applicants are unable to find where is disclosed in Nakata that element 20 performs both functions.

Furthermore, it was asserted that Figs. 4C and 4D of the Nakata disclose that the processing delay circuit delays starting of the period by a time point which is not earlier than termination of the discharge current.

However, Nakata discloses in column 5, lines 24 to 29 that in the processing circuit 20, a knock detection period is set in such a manner as to avoid the LC resonance current due to the residual magnetic energy, as shown in FIG. 4D. By passing the ion current output signal only during this period through the band-pass filter, only the frequency component peculiar to knock is extracted. Therefore, Nakata fails to disclose or suggest that such a delay is determined either on the discharge current or ionization current, as in the present invention.

Thus, upon review of Nakata, Applicants respectfully submit that Nakata fails to disclose or suggest a system for detecting misfire having a processing delay circuit

inputs at least one of the discharge current and the ionization current and based on the inputted current, delays starting of the period by a time point which is not earlier than termination of the discharge current, as recited in claim 1, or a processing delay circuit which inputs at least one of the discharge current and the ionization current and based on the inputted current, delays starting of the period by a time after the ionization current begins to flow, as recited in claim 9. Nakata also fails to disclose or suggest a processing delay circuit which inputs the discharge current and based on the inputted current, delays starting of the period by a time after the discharge current cease to flow, as recited in claim 13 or a method of detecting misfire including inputting at least one of the discharge current and the ionization current and based on the inputted current, delays starting of the period by a time point which is not earlier than termination of the discharge current, as recited in claim 17.

Therefore, it is respectfully submitted that the Applicants' invention, as set forth in claims 1, 9, 13 and 17, is not anticipated within the meaning of 35 U.S.C. § 102.

As claims 18-20 are dependent upon claim 17, Applicants submit that each of these claims incorporate the patentable aspects thereof, and are therefore, allowable for at least the same reasons.

Claims 2-8, 10-12 and 14-16 were rejected under U.S.C. § 103(a) as being unpatentable over Nakata in view of Noel (U.S. Patent No. 6,360,587). In making this rejection, the Office Action took the position that Nakata discloses all the elements of the claimed invention except for a comparator and an integration capacitor. Noel is cited for disclosing these limitations.

Noel discloses a pre-ignition detector. Ion sensing circuit 28 is configured to provide means for sensing the ion current I_{ION} and to generate an ion sense signal. The ion sense signal represents the ion current through the spark plug. As shown in Fig. 1, processing circuit 44 is responsive to ion sense signal V_{ION} for generating a pre-ignition signal. As shown in Fig. 2A, circuit 44 includes an inverter circuit 52, a comparator circuit 62, and a comparator 70. Circuit 52 inverts the raw ion signal V_{ION}. The inverted ion voltage signal is then compared to predetermined reference voltage V_{REF}. Comparator 70 generates a digital output pulse indicative of pre-ignition combustion. When comparator 70 fails to generate a pulse, this indicates that a misfire has occurred. As shown in Fig. 2B, processing circuit 44 includes an integrator circuit 72. A charging current I proportional to the generated ion current I_{ION} is received through diode 78 and charges capacitor 76. Capacitor 76 operates to integrate the ion sense signal V_{ION}, which accumulates on capacitor 76 as V_{CAP}. The integrated signal is compared to a reference voltage V_{REF}.

Although Noel discloses that "[o]ther detection windows, such as a second detection window 82 shown in Fig. 3C may alternatively be employed," (see col. 6, lines 22-24), this merely indicates that, in order to detect pre-ignition, the window may be set at any time point before the spark occurs (e.g., col. 1, lines 59-63).

The Office Action took the position that it would be obvious to modify Nakata by the teaching of Noel to provide an exemplary embodiment of the processing circuit to perform the appropriate functions. However, Applicants respectfully disagree.

Firstly, as we discussed above, Nakata fails to disclose or suggest all the elements of the claimed invention. Thus, Noel fails to cure any of the deficiencies of Nakata.

Secondly, we are of the opinion that this is an improper rejection because the only reason for making the proposed modifications in the manner suggested is taken from Applicants' specification.

Therefore, it is respectfully submitted that the Applicants' invention, as set forth in claims 2-8, 10-12, and 14-16, is not obvious within the meaning of 35 U.S.C. § 103.

As claims 2-8 depend from claim 1, claims 10-12 depend from claim 9, and claims 14-16 depend from claim 13, Applicants respectfully submit that each of these claims incorporate the patentable aspects thereof, and are therefore allowable for at least same reasons as discussed above.

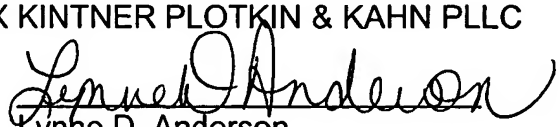
In view of the foregoing, reconsideration of the application, withdrawal of the outstanding rejections, allowance of claims 1-20 and the prompt issuance of a Notice of Allowability are respectfully solicited.

If this application is not in condition for allowance, the Examiner is requested to contact the undersigned at the telephone listed below.

In the event this paper is not considered to be timely filed, the Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension, together with any additional fees that may be due with respect to this paper, may be charged to counsel's Deposit Account No. 01-2300, **referencing docket number 107101-00038.**

Respectfully submitted,

ARENT FOX KINTNER PLOTKIN & KAHN PLLC



Lynne D. Anderson
Attorney for Applicants
Registration No. 46,412

Customer No. 004372
1050 Connecticut Avenue, NW, Suite 400
Washington, DC 20036-5339
Telephone: (202) 857-6000

CMM/LDA:elz

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